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Lawrence Berkeley National Laboratory

Carbon Cycle 2.0

U.S. DEPARTMENT OF ENERGY

Energy Demand in China

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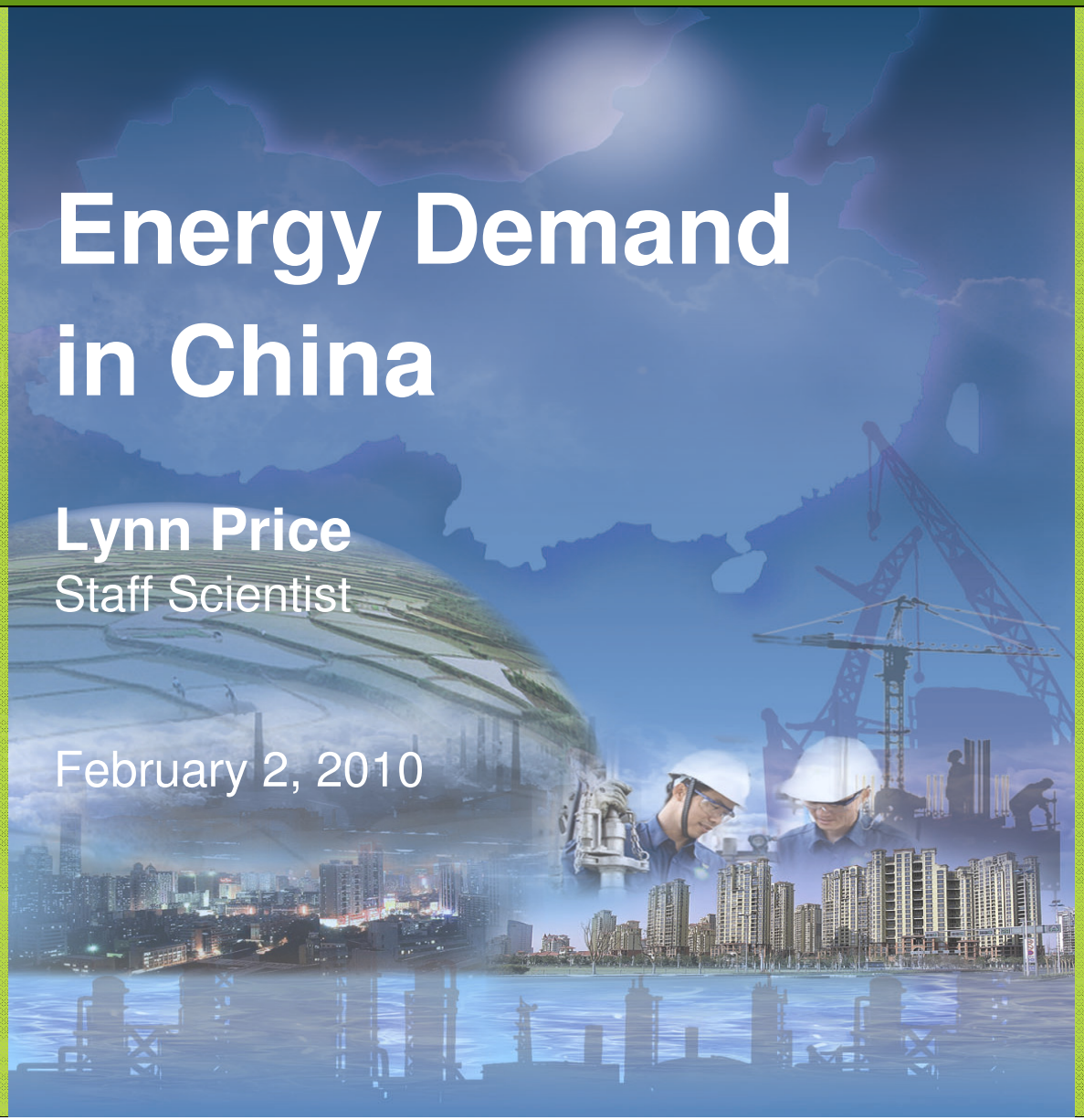
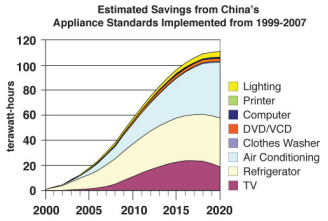
February 2, 2010

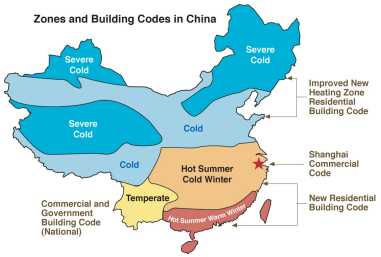


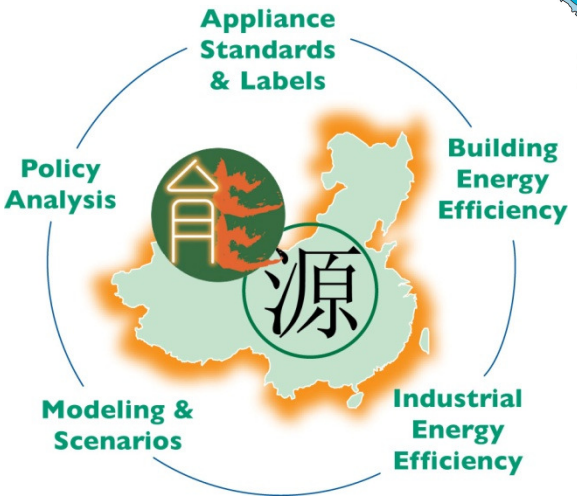
China Energy Group

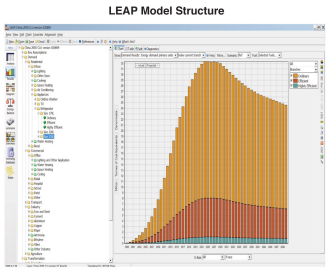
Founded in 1988

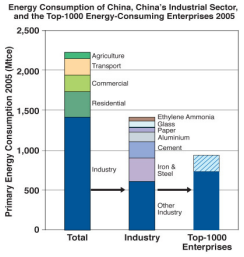
Focused on End-Use Energy Efficiency











~ 40 Current Projects in China

Collaborations with ~50 Institutions in China

China Energy Group

Mark D. Levine
Group Leader, Senior Staff Scientist

David Fridley
Deputy Group Leader
Staff Scientist

Nan Zhou
Scientist

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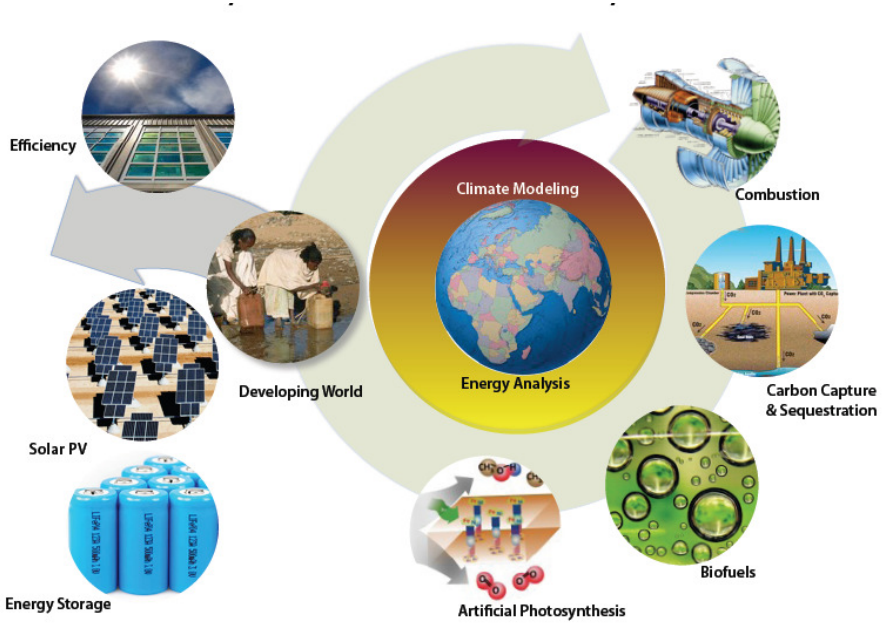
Shuqin Chen
Post Doc

Jing Ke
Visiting Researcher

Stephanie Ohshita
Visiting Faculty

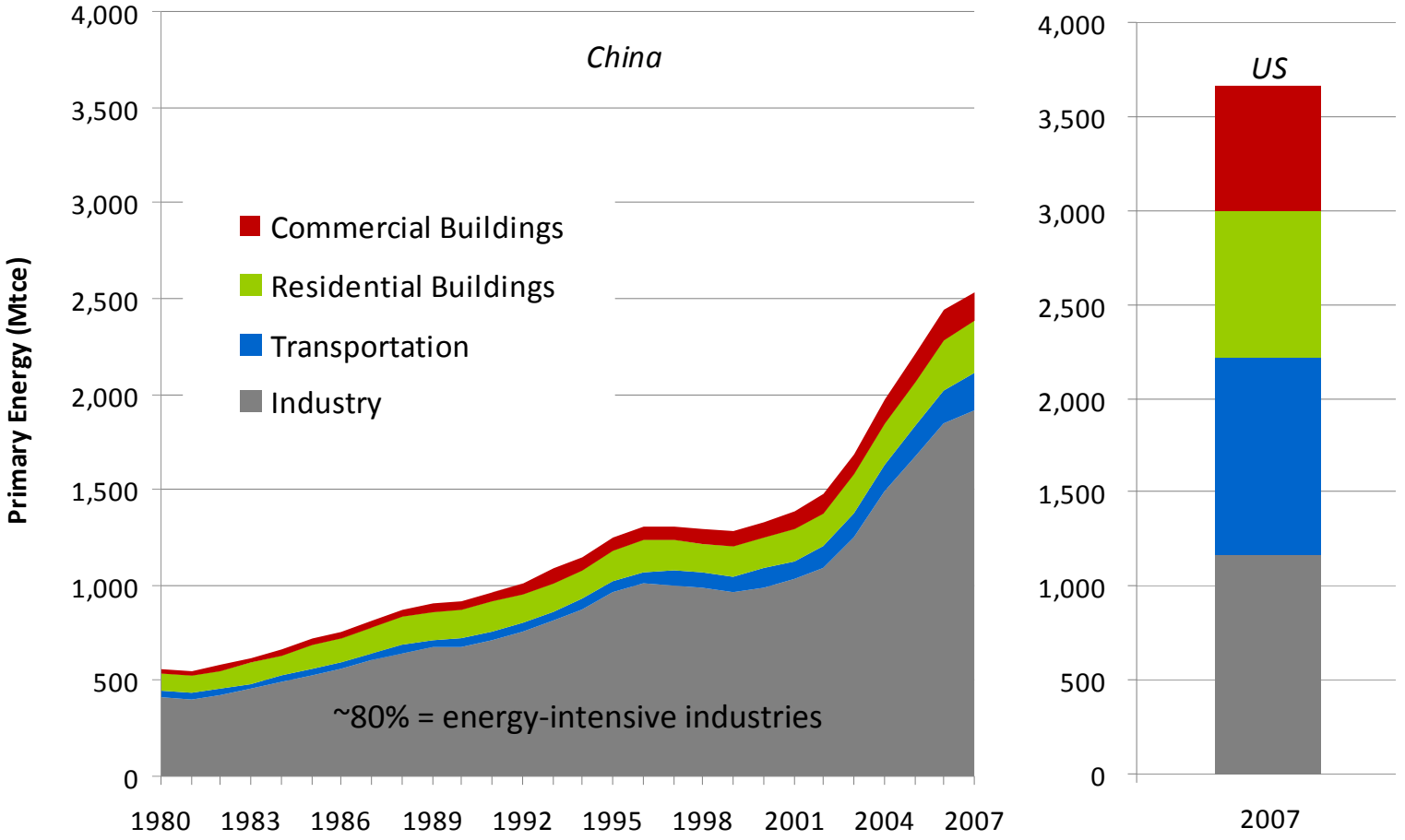
Queena Qian
Visiting Researcher

Talk Outline



- Overview
  - China's energy use and CO_2 emission trends
  - Energy intensity trends and policy background
- Focus on Industrial Energy Efficiency
  - Policy analysis and assistance
  - Technology analysis and assistance
- Current Situation
- Links to Carbon Cycle 2.0 Initiative

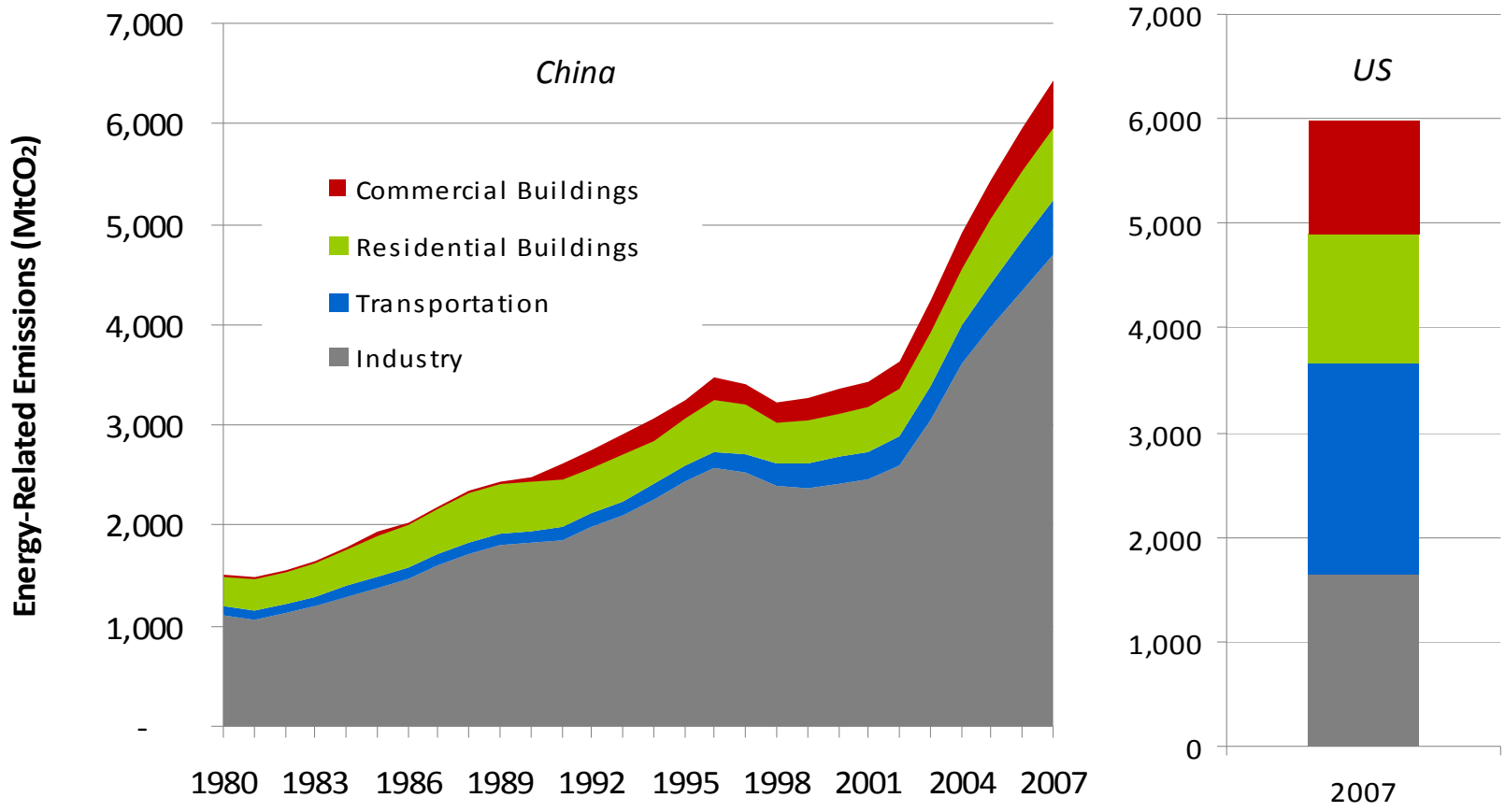
Overview:
Energy Use in China and the U.S.



Sources: China National Bureau of Statistics; U.S. Energy Information Administration, *Annual Energy Outlook*.

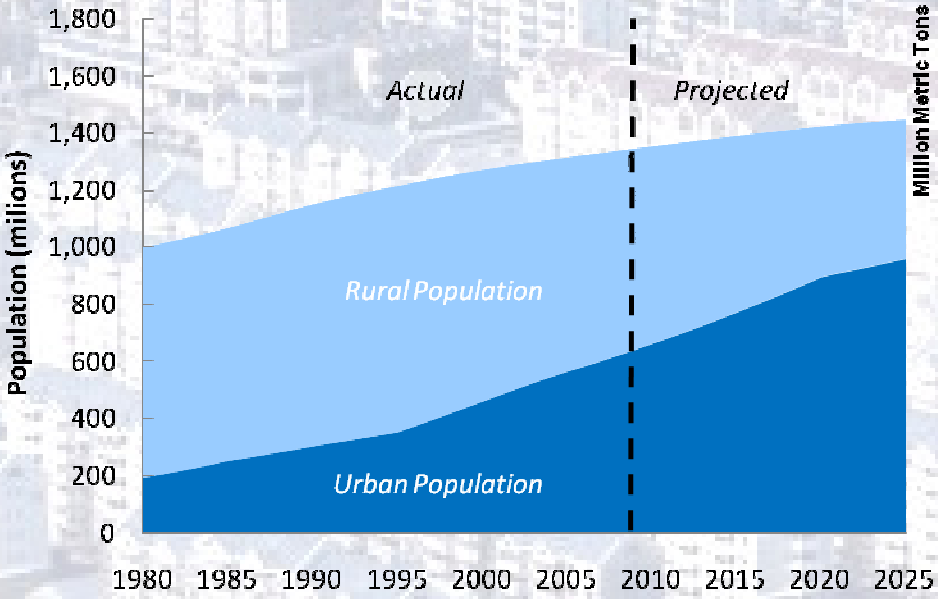
Note: Mtce >> EJ = 0.0293; EJ >> Quads = 0.9478

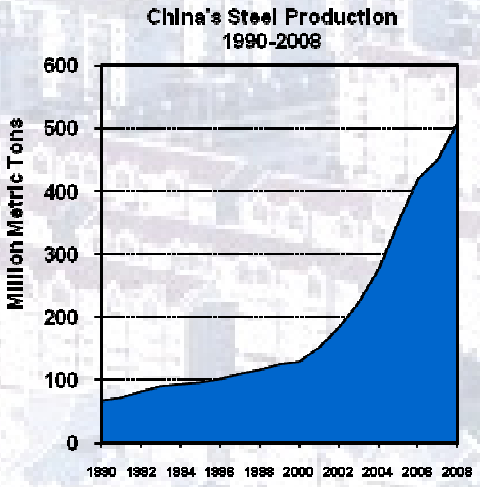
Overview: Energy-Related CO2 Emissions in China and the U.S.



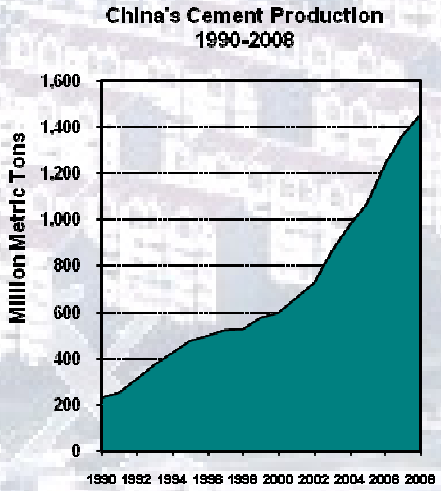
Source: U.S. Energy Information Administration, 2008, *Emissions of Greenhouse Gases Report*, available at: http://www.eia.doe.gov/oiaf/1605/ggrpt/carbon.html; China emissions calculated using 1996 revision of IPCC default carbon emission factors; commercial fuels only, not including biomass.

Overview:
Key Energy Demand Drivers



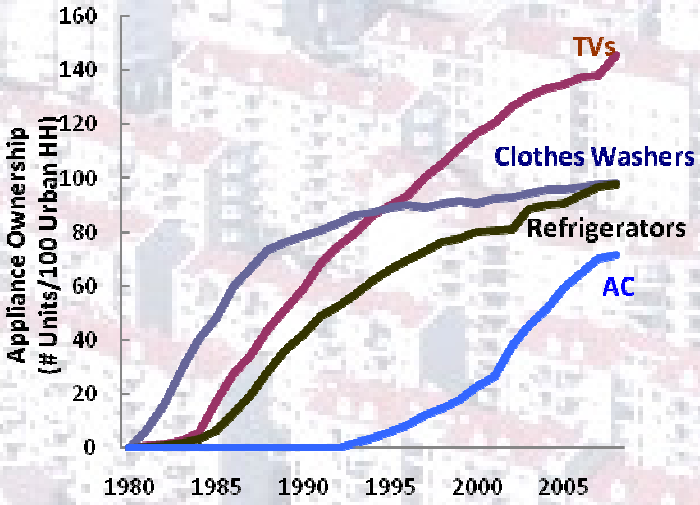


Japan 120 Mt, US 92 Mt

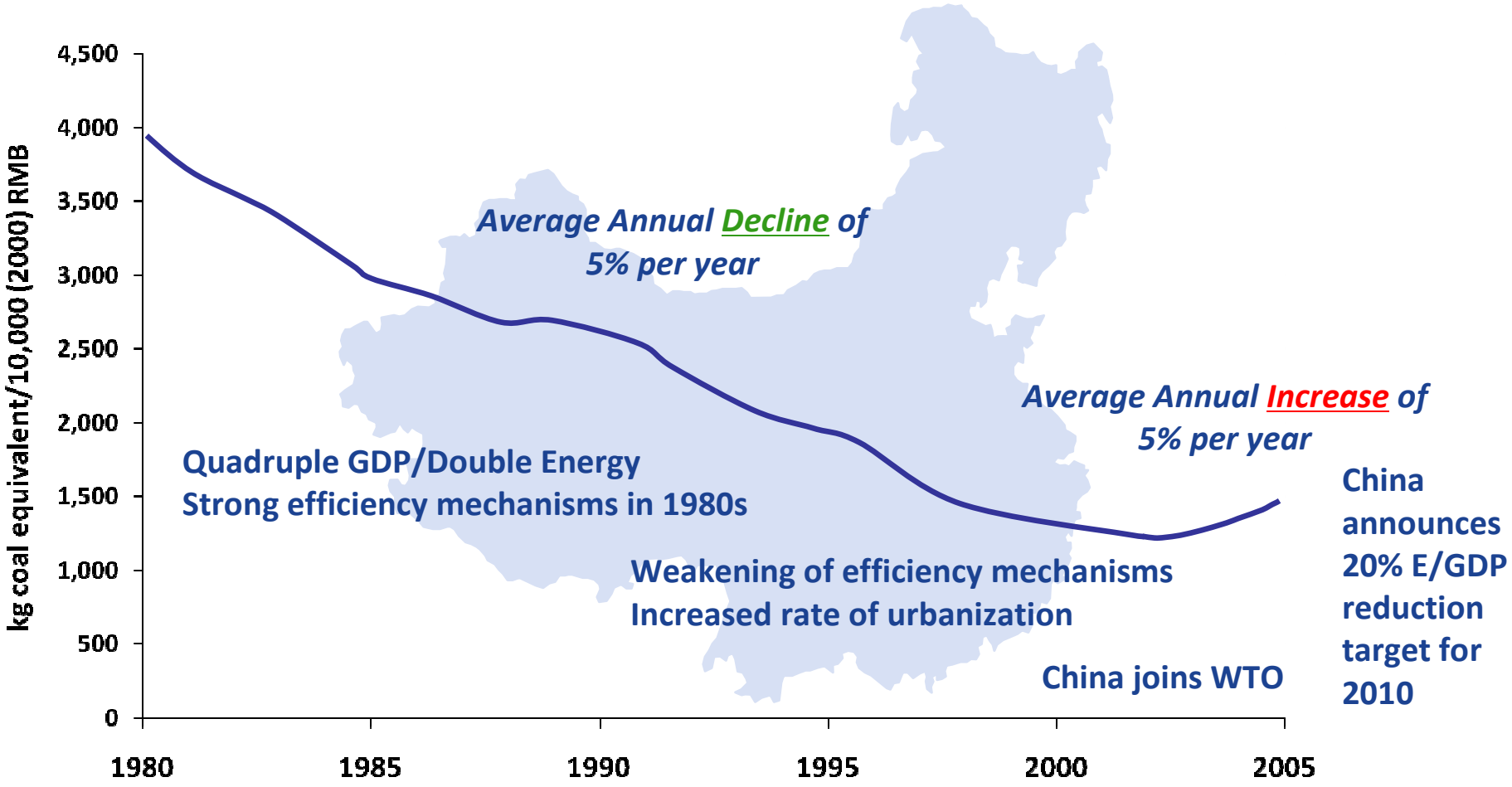


India 175 Mt, US 90 Mt

- *290 million new urban residents 1990-2007*
- *375 million new urban residents 2007-2025*



Overview: Energy Intensity Trends and Policy Background



Source: National Bureau of Statistics, *China Statistical Abstract*, various years.

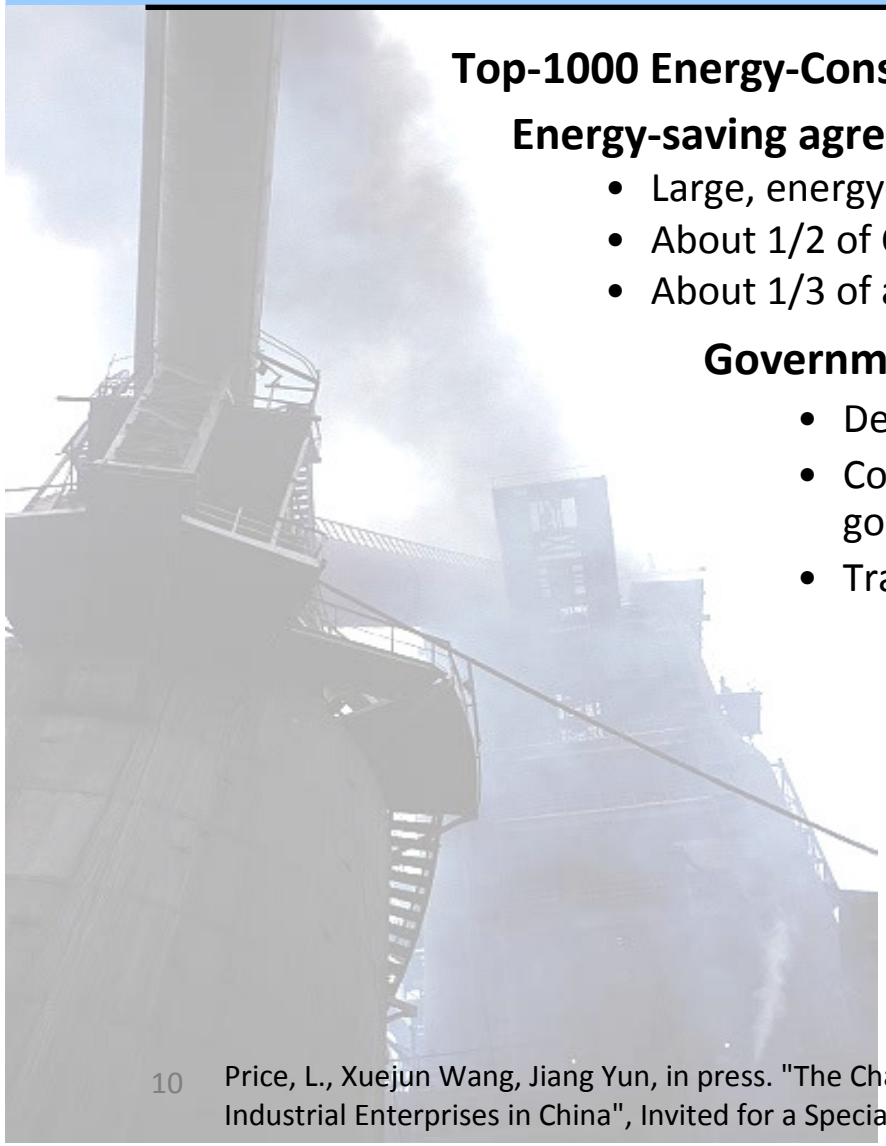
Zhou, N., Levine, M.D., and Price, L., in press. "Overview of Current Energy-Efficiency Policies in China." Invited for a Special Issue of *Energy Policy*.

Industrial Energy Efficiency Policy Analysis and Assistance

- Policy analysis: *how to provide policy stimulus to improve China's industrial energy efficiency?*
  - Global survey
  - Negotiated agreements
- Policy assistance: pilot policy project
  - 2 steel mills in Shandong Province
  - Technical assistance setting energy-saving targets
  - Agreement contracts signed 2003
  - Both plants:
    - Implemented strong energy management programs
    - Established monitoring and reporting protocols
    - Reduced energy consumption per ton steel
- Model for national program

Price, L., Worrell, E., and Sinton, J., 2004. "Designing Energy Conservation Voluntary Agreements for the Industrial Sector in China: Experience from a Pilot Project with Two Steel Mills in Shandong Province," in *The Handbook of Environmental Voluntary Agreements*, E. Croci, ed., Kluwer Academic Publishers

Industrial Energy Efficiency Policy Analysis and Assistance



Top-1000 Energy-Consuming Enterprises Program

Energy-saving agreements

- Large, energy-intensive industries
- About 1/2 of China's industrial energy use
- About 1/3 of all energy use in China

Government actions:

- Defined 2010 energy-saving targets
- Contracts: Central government >> Provincial governments >> Top-1000 enterprises in each province
- Track, supervise, and monitor enterprises

Enterprises commitments:

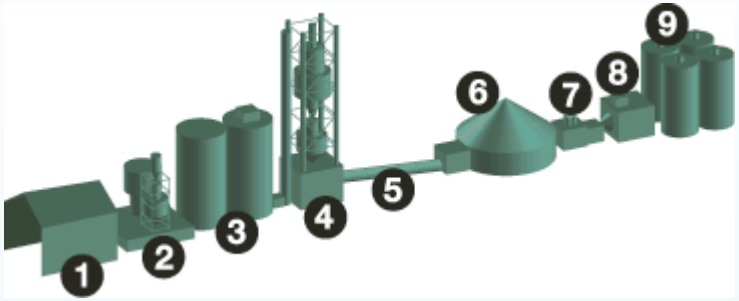
- Energy audits and benchmarking
- Energy conservation plans
- Monthly energy use reporting system
- Annual reports
- Adopt energy conservation measures

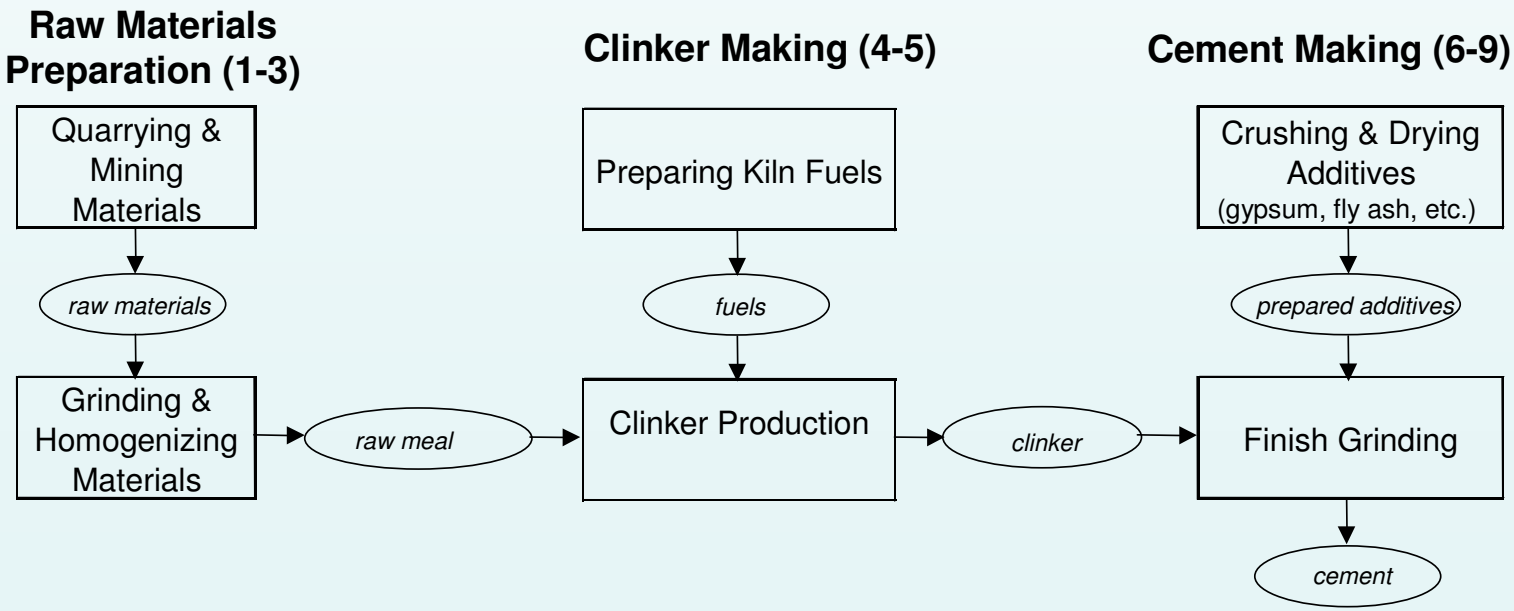
LBNL providing technical assistance

Price, L., Xuejun Wang, Jiang Yun, in press. "The Challenge of Reducing Energy Consumption of the Top-1000 Largest Industrial Enterprises in China", Invited for a Special Issue of *Energy Policy*.

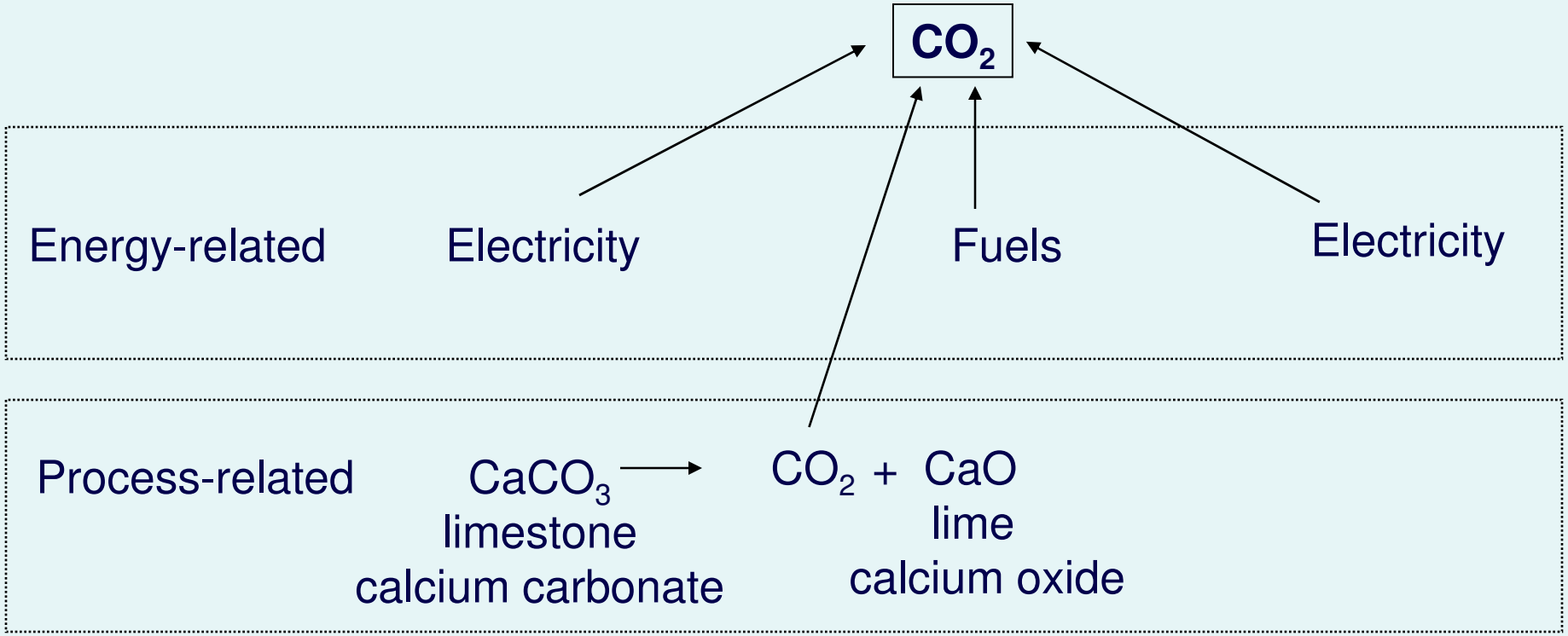
Industrial Energy Efficiency Technology Analysis and Assistance

Cement Manufacturing





Industrial Energy Efficiency Technology Analysis and Assistance



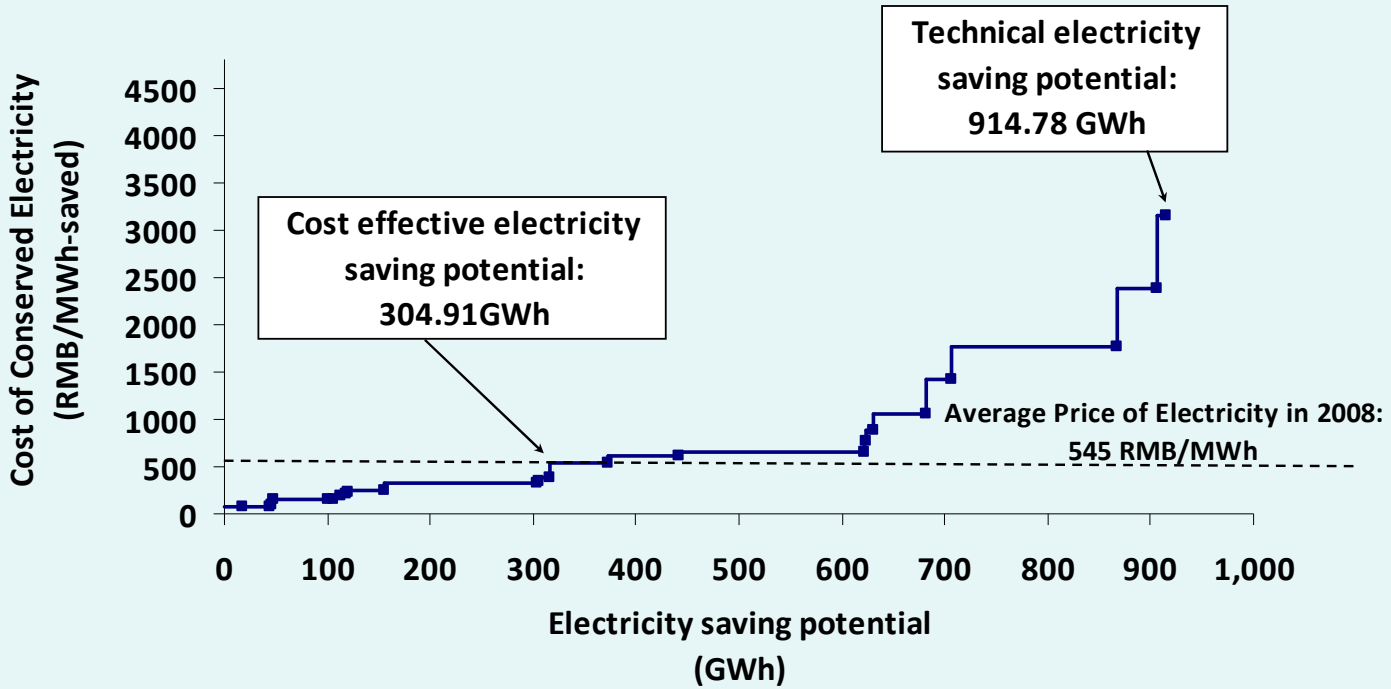
Roughly 1 tCO2/t cement, divided about equally between energy- and process-related

Industrial Energy Efficiency Technology Analysis and Assistance

- Characterization of energy-efficiency technologies and measures
  - Description
  - Typical energy savings
  - Cost of implementation
  - Simple payback period
- Used to develop
  - Energy conservation supply curves
  - Benchmarking tool

Industrial Energy Efficiency Technology Analysis and Assistance

- Shandong Province energy efficiency potential study
  - 16 modern cement plants
  - 34 energy-efficiency technologies and measures



Hasanbeigi, A., Price, L., Lu, H., Wang, L., in press. "Analysis of Energy-Efficiency Opportunities for the Cement Industry in Shandong Province, China: A Case-Study of Sixteen Cement Plants, " *Energy, The International Journal*.

Industrial Energy Efficiency Technology Analysis and Assistance

Benchmarking and Energy Saving Tool for Cement Sector in China

China Building Materials Academy, China Cement Association, Energy Research Institute

Benchmarks a cement plant to world and Chinese best practice by process step

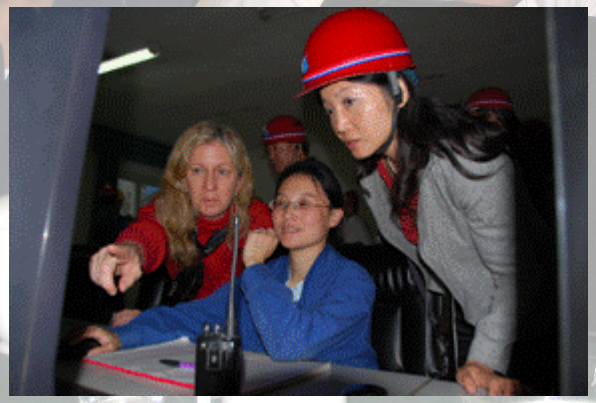
$$EII = 100 \cdot \frac{\sum_{i=1}^{n} P_i \cdot EI_i}{\sum_{i=1}^{n} P_i \cdot EI_{i,BP}} = 100 \cdot \frac{E_{tot}}{\sum_{i=1}^{n} P_i \cdot EI_{i,BP}}$$

EII	= energy intensity index
n	= number of processes to be aggregated
EI_i	= actual energy intensity for process I
$EI_{i,BP}$	= best practice energy intensity for process i
P_i	= production quantity for process i
E_{tot}	= total actual energy consumption for all processes

- Menu of ~50 energy-efficiency measures
- Provides information on each measure
  - Description
  - Typical energy savings
  - Cost of implementation
  - Simple payback period

Industrial Energy Efficiency Technology Analysis and Assistance

- Beta-tested BEST-Cement with two cement plants in China in April 2008
- 2-day hands-on training sessions in July and October 2008
  - Shandong, Shanxi, Hebei, and Sichuan Provinces
  - Trained ~300 cement plant staff /over 200 cement facilities
- BEST-Cement, DOE energy auditing tool, WRI/WBCSD GHG Protocol tool
  - Trained trainers: July 2009
  - Energy audits of 42 plants: 2009/2010
- Follow-up in 2010/2011 to assess uptake/barriers



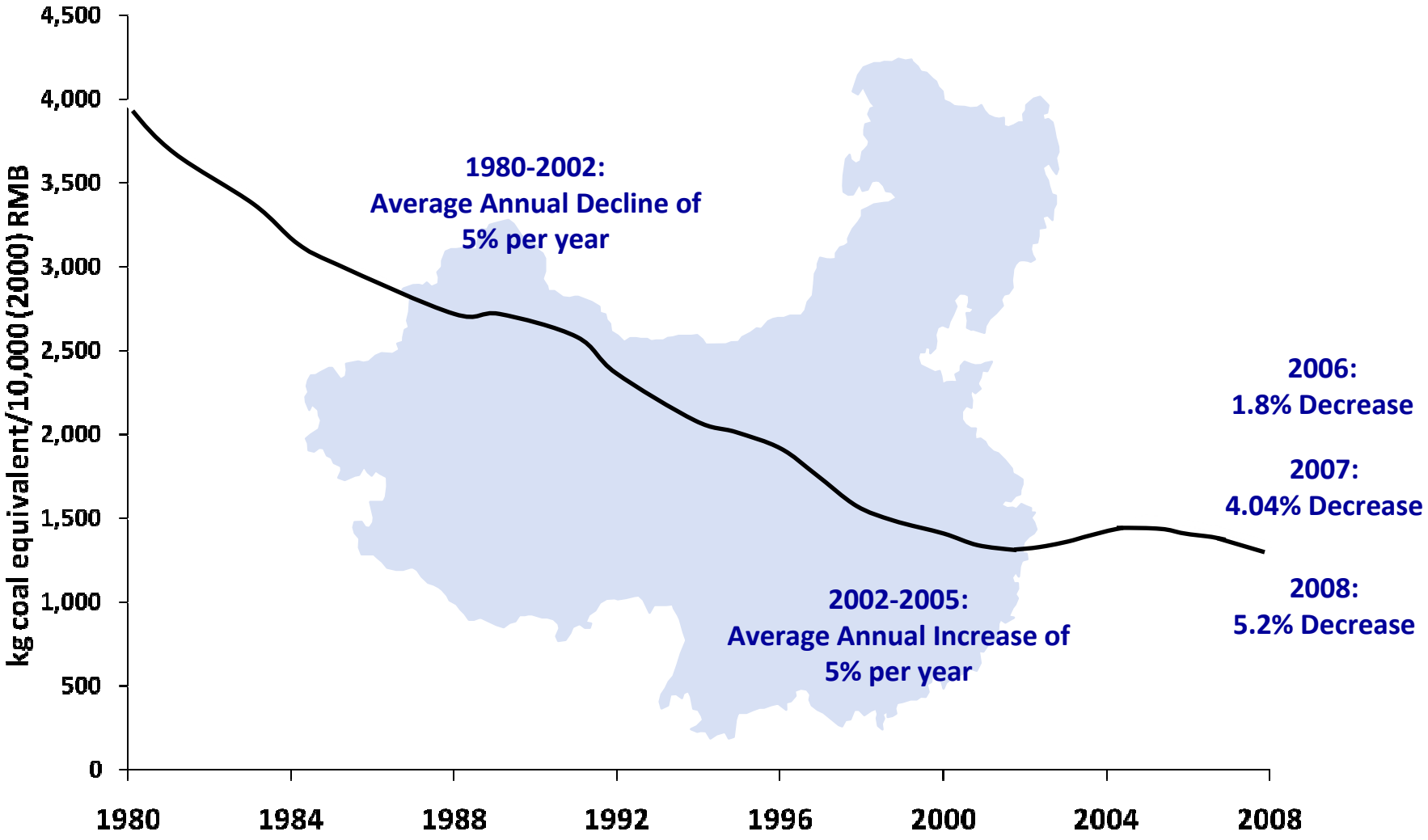
Current Situation

Energy Efficiency Programs - 11th Five Year Plan

- **Top-1000 Program**
  - Goal: savings of 100 Mtce in 2010
  - 2009: program has reached goal of 100 Mtce savings (~ 250 MtCO2)
- **Ten Key Projects**
  - Boiler retrofits, CHP, waste heat recovery, motor systems, green lights, government procurement, etc.
  - Goal: savings of 250 Mtce in 2010
- **Buildings Energy Efficiency**
  - Mininum efficiency standards, efficiency retrofits, heating system reform, energy management
  - Goal: savings of 100 Mtce in 2010
- **Appliance Standards and Labels**
  - ~ 30 minimum efficiency standards, plus energy efficiency labels
  - 80 Mtce savings will be realized during 11th FYP
- **Small Plant Closures**
  - 13 industrial sectors
  - Goal: savings of 118 Mtce by 2010

Source: Levine, M.D., Price, L., Zhou, N., Fridley, D., Aden, N., Lu, H., McNeil, M., Zheng, N., Qin, Y., Yowargana, P., in press. *Assessment of China's Energy-Saving and Emission-Reduction Accomplishments and Opportunities During the 11th Five-Year Plan*. Berkeley, CA: Lawrence Berkeley National Laboratory.

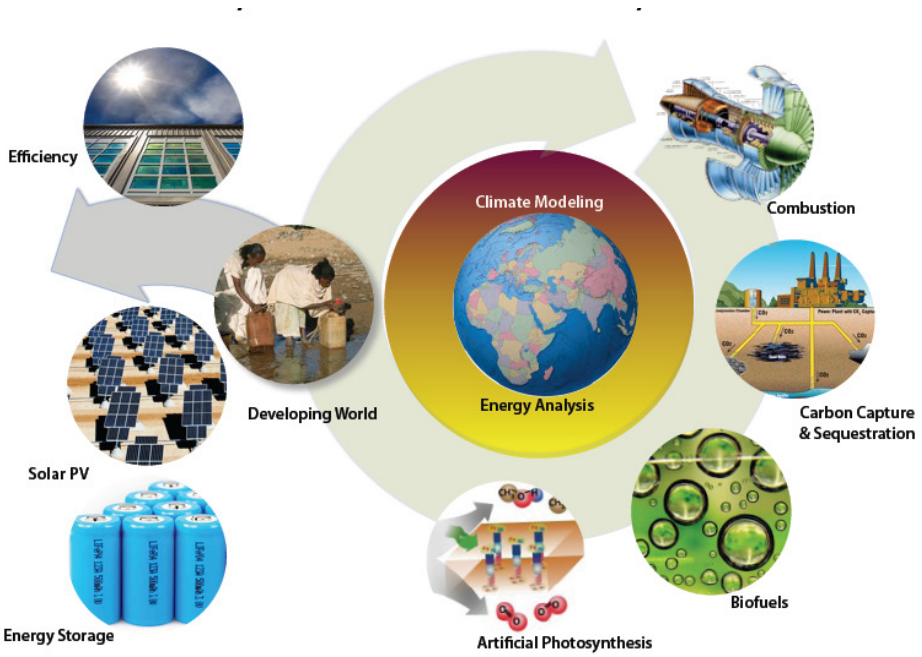
Current Situation



Source: National Bureau of Statistics, *China Statistical Abstract*, various years.

Links to Carbon Cycle 2.0 Initiative

- Government willing to try pilot-scale initiatives
  - Test innovative energy efficiency or emissions reductions policies and programs
  - Test new technologies
- Huge "scale-up" potential
  - Goal for wind, solar and biomass to represent 8% of China's electric generation capacity by 2020 (~100 GW)
- Significant interest in areas covered by CC 2.0



For Further Information…

LBNL's China Energy Group website: http://china.lbl.gov/
China Energy Databook: http://china.lbl.gov/research/china-energy-databook
China Energy Primer:
http://china.lbl.gov/research/china-energy-databook/china-energy-primer

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